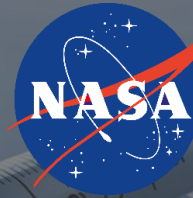


## Health Stabilization Program (HSP)

OCHMO-TB-006  
Rev C



## Executive Summary

A comprehensive Health Stabilization Program (HSP) is needed for all spaceflight missions to reduce infections pre-flight and prevent subsequent symptoms in-flight. Among other considerations, the increased incidence of infectious diseases in-flight requires additional resources to treat the crew and results in decreased crew performance. A HSP has been implemented since the Apollo 14 mission and has led to substantial mission success. The two biggest components of the HSP are pre-flight immunizations and quarantine. Through a combination of these two factors, in-flight infectious diseases (especially upper respiratory and enteric infections) can be mitigated. Current NASA/JSC protocol mandates the HSP begin 14 days prior to launch. If the crew will not be in space for a considerable amount of time (e.g., less than 1 day), an extensive HSP may not be as critical when compared to a longer-duration mission (e.g., Shuttle or ISS). However, physical contact between non-HSP and HSP crew must be considered. The HSP can only be successful if there is full participation by all in-flight physical contacts of the crew.



### Relevant Technical Requirements

NASA-STD-3001 Volume 1, Rev B  
[V1 3002] Pre-Mission Preventive Health Care



*SpaceX Crew 1 during pre-flight quarantine*



*Shuttle program health promotion poster*

## Flight Crew Health Stabilization Program

### Clinical Medicine

- Rapid Diagnosis
- Therapy

### Immunology

- Serology
- Immunization

### Exposure Prevention

- Fomites
- Consumables
- Contacts

### Epidemiological Surveillance

- Medical History
- Medical Surveillance



## Background

### Pre- and Post-Implementation of an HSP in Apollo Missions

Infectious diseases significantly impacted pre-flight and in-flight phases of Apollo missions 7 – 13. After the implementation of a flight crew HSP (FCHSP), a noticeable reduction in illness incidence occurred:

| Mission                        | Illness                     | Number of Crewmembers Involved | Mission Phase       |
|--------------------------------|-----------------------------|--------------------------------|---------------------|
| Before Implementation of FCHSP |                             |                                |                     |
| Apollo 7                       | Upper respiratory infection | 3                              | Preflight, inflight |
| Apollo 8                       | Viral gastroenteritis       | 3                              | Preflight, inflight |
| Apollo 9                       | Upper respiratory infection | 3                              | Preflight, inflight |
| Apollo 10                      | Upper respiratory infection | 2                              | Preflight, inflight |
| Apollo 11                      | None                        | -                              | -                   |
| Apollo 12                      | Skin infection              | 2                              | Inflight            |
| Apollo 13                      | Rubella                     | 1                              | Preflight           |
| After Implementation of FCHSP  |                             |                                |                     |
| Apollo 14                      | -                           | -                              | -                   |
| Apollo 15                      | -                           | -                              | -                   |
| Apollo 16                      | -                           | -                              | -                   |
| Apollo 17                      | Skin infection              | 1                              | Preflight           |

- Prior to the HSP implementation, 57% of Apollo crewmembers experienced some level of infectious illness before flight
- Since Apollo 14, a HSP (featuring quarantines and immunizations) has been used before every flight to reduce infectious disease risk. While the risk cannot be completely eliminated, a comprehensive HSP presents a way to significantly reduce hazard

### Reference Documents

- SP-368 Biomedical Results of Apollo, Section II: Crew Health and Inflight Monitoring
- Biomedical Results of Skylab, Chapter 7: Analysis of the Skylab Flight Crew Health Stabilization Plan
- SSP 50480-ANX1 Guidelines and Procedures for the Prevention of Infectious Disease Transmission to ISS Crewmembers
- JSC-22538 Flight Crew Health Stabilization Program, Rev. F



## Reference Data

### Past and Current HSPs

#### Apollo

- 21-day HSP for prime and backup crew
- Immunizations
  - Diphtheria, Pertussis, Tetanus, Typhoid, Influenza, Mumps, Poliomyelitis, Rubella, Rubeola, Smallpox, and Yellow Fever.
- Extensive disease exposure prevention via quarantine
  - Limited exposure to fomites, contaminated consumables, and interpersonal contacts
  - Crewmembers used different equipment
  - Closely controlled living environment – ultra-high efficiency bacterial filters, positive air pressure (outward flow of air only), and controlled food and water intake (including microbiological testing of samples)
  - No exposure to potential carriers (e.g., children, maintenance personnel); contacts restricted to medically approved individuals only (~100 people total)

#### Skylab

- 21-day pre-flight, 7-day post-flight HSP
- Immunizations similar to Apollo
- Quarantines to minimize crew exposure to infectious diseases; additional space for isolation of an ill crewmember
  - Similar to Apollo – positive air pressure
  - Primary contacts were inspected by a nurse before interaction with crew; interactions with non-primary contacts were performed via closed-circuit television (CCTV). Limitations set on number of primary contacts cited as the change that most significantly impacted incidence of disease.
  - Food was specially prepared for the crew

#### Space Shuttle Program

- 7-day pre-flight HSP
  - Quarantine facilities were made available 10 days pre-flight if needed for premature isolation
- Limited number of primary contacts, trained to avoid physical contact with crewmembers and heightened personal hygiene practices (e.g., hand washing); children <14 years of age restricted
- Pre-visit exams including temperature screening and vaccination requirements
- Maintenance of practices established during Apollo and Skylab, including vaccination and isolation space for crewmembers showing signs of illness while in quarantine
- The HSP was largely successful in preventing the occurrence of infectious disease that would affect launch; only one Space Shuttle flight was delayed because of infectious disease (respiratory) among the crew

#### ISS

- 14-day pre-flight HSP
- Countermeasures in place: crew and contact education; hand & respiratory hygiene; physical separation; personal protective equipment (PPE); immunizations (similar to Apollo); medical screening of contacts by medical personnel before crew interaction; and avoiding tasks with a high risk of infectious disease acquisition
- HSP participants are allowed to have close crew contact, but special guests and VIPs must stay >2 meters away and/or wear PPE. Participants are limited to 5 people or family members (with exceptions)
  - May be isolated prior to crew contact, depending on when they arrive at the site
- Additional considerations are in place for management of SARS-CoV-2 (COVID-19) risks



## Application

### Considerations when Implementing an HSP

- Back-up crewmembers, in addition to the prime crew, should be considered in the HSP in the event of crew swaps
- The incubation period for almost all non-immunization, preventable infectious diseases is  $\leq 3$  weeks
  - To ensure minimized risk, isolation/quarantine periods should include at least the 2 weeks prior to launch
  - Isolation/quarantine periods are reviewed and updated routinely based on evolving risks
- Access to quarantine facilities should only be for mission-required purposes
- Pertinent modes of transmission for infectious disease prevention include contact, droplet ( $>5\mu\text{m}$ ), airborne ( $\leq 5\mu\text{m}$ ), and blood-borne
- HSP Participants
  - Any individual who requires access to the quarantine facility for mission-related purposes – may or may not come into contact with the crew
  - Includes operational groups, crew family/personal contacts, special guests & VIPs, aircrew, and staff with access to the crew quarters/vehicle
  - All participants should be medically screened by physician or medical personnel via questionnaires and physical exams before contact with the crew

| Current Immunizations Required for Crew and HSP Participants |                 |
|--|-----------------|
| Measles  | Poliomyelitis   |
| Mumps  | Varicella       |
| Rubella  | Hepatitis A & B |
| Diphtheria   | Influenza       |
| Pertussis  |                 |

### Immunodeficiency of Deconditioned Crew

- Stress from spaceflight has shown subclinical research findings (findings that can be measured but do not require medical intervention) on immune system function.
- NASA continues to monitor immune system function but presently does not provide any additional post mission medical care related to the findings.
- NASA continues to ensure that crewmembers receive adequate nutrition, exercise, and behavioral health support to minimize the stress of spaceflight.
- Post-flight deconditioned crew care should consider each individual crew member's personal health and relation to stress to determine if additional post mission quarantine measures are needed.

Studies have suggested that stress hormone levels are elevated post-flight and correlate with mission duration. T cell, natural killer cell, monocyte, and neutrophil function may diminish during and/or after spaceflight.

*Source: Makedonas et al. (2020)*



# Back-Up



## Major Changes Between Revisions

### Rev B → Rev C

- Added information regarding immunodeficiency of deconditioned crew to slide 4.

### Rev A → Rev B

- Updated information to be consistent with NASA-STD-3001 Volume 1 Rev B and Volume 2 Rev C.

### Original → Rev A

#### Slide 1:

- Reformatting of chart

#### Slide 2:

- Reformatting of chart

#### Slide 3:

- Medical screening of contacts by a physician → medical personnel
- Updated Personal Contacts (PCs) to HSP Participants
- Updated requirements for HSP participants (distance and number of participants allowed; use of PPE)
- Added statement for management of SARS-CoV-2 (COVID-19) risks
- Reformatting of chart

#### Slide 4:

- Added: isolation/quarantine period updates
- Updated Personal Contacts (PCs) to HSP Participants
- Added two immunizations to list [influenza, SARS-CoV-2 (COVID-19)]
- Removed the following statement: "Influenza vaccination is not a requirement; if the PC has not received, then they must wear PPE"



## Referenced Technical Requirements

### NASA-STD-3001 Volume 1 Revision B

**[V1 3002] Pre-Mission Preventive Health Care** Pre-mission preventive strategies shall be used to reduce in-mission and long-term health medical risks, including, but not limited to:

Flight surgeon monitoring of crewmembers during hazardous training and pre-flight science testing.

- a. Optimization of nutrition.
- b. Vitamin D supplementation.
- c. Triennial imaging of bone mineral density.
- d. Maintenance of optimal aerobic and strength physical fitness.
- e. Maintenance of flexibility, agility, and balance.
- f. Annual physicals.
- g. Preventive dental care.
- h. Vaccinations (influenza, tetanus toxoid, varicella zoster vaccine, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), etc.
- i. Behavioral health resiliency training.
- j. Total radiation dose control/monitoring.
- k. Pre-mission Health-Stabilization Program (HSP) to reduce the likelihood of contracting an infectious disease before launch.
- l. Assisted Reproductive Technology (ART) if desired by the crewmember to preserve gametocytes prior to missions with exposure to radiation.





## Reference List

1. NASA-STD-3001 Volume 1, Revision A with Change 1. (2015).  
<https://www.nasa.gov/sites/default/files/atoms/files/nasa-std-3001-vol-1a-chg1.pdf>
2. SP-368 Biomedical Results of Apollo, Section II: Crew Health and Inflight Monitoring.  
<https://history.nasa.gov/SP-368/contents.htm>
3. Biomedical Results of Skylab, Chapter 7: Analysis of the Skylab Flight Crew Health Stabilization Plan. [https://lsda.jsc.nasa.gov/books/skylab/biomedical\\_result\\_of\\_skylab.pdf](https://lsda.jsc.nasa.gov/books/skylab/biomedical_result_of_skylab.pdf)
4. SSP 50480-ANX1 Guidelines and Procedures for the Prevention of Infectious Disease Transmission to ISS Crewmembers
5. JSC-22538 Flight Crew Health Stabilization Program, Rev. F
6. Makedonas, G., Mehta, S.K., Scheuring, R.A., Haddon, R., and Crucian, B.E. (2020). SARS-CoV-2 Pandemic Impacts on NASA Ground Operations to Protect ISS Astronauts. *The Journal of Allergy and Clinical Immunology: In Practice*, 8(10): 3247-3250.  
<https://doi.org/10.1016/j.jaip.2020.08.064>